ASBESTOS

Settled Dust Analysis Used in Assessment of Buildings Containing Asbestos

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ABSTRACT

Recent USEPA recommendations state that "before deciding upon an asbestos removal project, a building owner should always consult a trained, experienced and qualified person who can assess his particular building situation and help him decide upon the most appropriate action, be it in-place management or some other action. As long as asbestos remains in the building, in-place management is recommended to prevent an episode which could elevate levels." (1)

DISCUSSION

For the experienced building assessor, microscopical analysis plays an important role in determining the asbestos situation within a building and how to advise an owner. Visual assessment of the condition of building materials is considered

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with the results of bulk analyses performed using polarized light microscopy (PLM). Ambient air samples collected while different activities are occurring in the building may be analyzed by phase contrast microscopy (PCM) or transmission electron microscopy (TEM) to give information about air levels at specific times in the building. Because the resuspension of settled fibers is one of the main sources of exposure (2,3) dust samples are also used by experienced assessors to gather information about the building situation. Frank Bull, an architect with considerable background in assessing public and private buildings feels that:

> Generally, if asbestos fiber is in the air, it will tend to subside over time and can be found on surfaces and in accumulations of dust. Where the asbestos source material is exposed and visible to the dusty surface, this may indicate disturbance or deterioration of the source. If asbestos fiber is found in dust samples taken from finished spaces where no asbestos source material is exposed and visible, it may indicate migration of fiber by some means, the most obvious being air currents. The most obvious air current, of course, is the delivery of air through the HVAC systems. Dust samples are thus considered to be very important in providing clues about conditions that may not be detected by other investigations, including air sampling. (4)

Collecting and analyzing settled dust to draw conclusions about airborne asbestos fibers goes back to at least 1935 when Hurlbut and Williams collected samples of rafter dust from six asbestos plants in various parts of the United States and characterized the fibers using PLM (5). In 1983, Dr. Speight of the Radiological and Safety Division of Winfrith, Dorchester, England indicated that he felt that guidance on acceptable levels of loose asbestos fiber on surfaces would be forthcoming from the various national authorities. He reasoned that "clearly, loose dust of any nature can become resuspended in air, and there must be a level of surface contamination at which the concentration of resuspended fibers, in the particular case of asbestos, approaches the recommended limits for breathing air". To aid in this effort Speight proposed a way to measure asbestos contamination of surfaces using a light microscope and system for Lieberkuhn illumination (6). This microscope illumination

system was used to increase the visibility of fine asbestos fibers by enhancing the contrast. Such levels have not yet been determined. However, in 1986 researchers at the National Institute of Occupational Safety and Health Administration and the West Virginia Department of Health presented a paper on the use of settled dust analysis to assess asbestos fiber release in buildings. Using PLM techniques, the researchers found that 35% of the samples collected from 28 buildings containing asbestos materials in a variety of conditions were positive for asbestos and appeared to correlate with observed or historical building conditions (7). The analysis procedure used did not allow for measure of the asbestos in the dust and the authors recommended that the feasibility of a quantitative settled dust test be considered.

After many years of analyzing dust samples for asbestos by PLM, McCrone Environmental Services, Inc. (MES) began in 1984 to work as well with a quantitative measure of the asbestos fibers in settled dust using transmission electron microscope methods based on the procedures for air and water. The technique was used in a number of building situations to determine the levels of asbestos in the settled dust. Values ranging from less than ten thousand asbestos structures per square foot to over a billion structures per square foot were reported in a presentation in 1988 on observations on studies useful for asbestos O & M activities (8). The method used is described as follows:

Sample Collection — Representative surface dust samples are collected by a method called microvacuuming in which an air sampling cassette is used to "vacuum" an area greater than 100 square centimeters using a personal sampling pump with a flow rate of 2.0 liters/minute. When it is possible to obtain a sample plug of a carpet the settled dust may be extracted by immersing the plug in a beaker of particle-free water and shaking the material loose in an ultrasonic bath. This method of sonicating carpet is similar to the preparation method for cloth and fabric samples developed by Chatfield and described in a May 1988 letter from the USEPA (9).

Sample Preparation — Surface dust samples are prepared by an indirect method, whereby the particulate is recovered from the filter and the interior of the cassette, and redistributed onto a 0.22 µm mixed cellulose ester filter by filtering an aliquot of the

total suspension. In many cases, several dilutions are needed to produce an acceptable particulate loading on the final filte Usually, a light discoloration of the filter produces a prope. loading. After the filters are dried, they are prepared for TEM analysis using the NIOSH Method No. 7402 (10) for the preparation of air samples for asbestos analysis.

Analytical Instrumentation — For many of the dust analyses performed by MES, a JEOL 100CX Transmission Electron Microscope with Tracor Northern 5400 x-ray analysis system was used. Selected area electron diffraction (SAED) and energy dispersive spectroscopy (EDS) were used to distinguish between chrysotile and magnesium-aluminum silicate clay fibers occasionally found in surface dust samples.

Sample Analysis — The counting and identification of asbestos structures in surface dust samples is based on EPA Level II counting rules (11). In this method the asbestos structures are identified utilizing morphology, SAED and elemental analysis by EDS.

The prepared TEM sample grids are assessed at low magnification (250X and 1000X) to ensure that grid openings are intact, and that the particle loading (<25% coverage) is acceptable. At a magnification of about 20,000X the analysis is performed assessing five openings each on two separate TEM grids or the counting of the 100th asbestos structure whichever comes first. The aspect ratio of the fibers must be at least three to one. This applies to both chrysotile and fibrous amphiboles.

Asbestos structures are characterized as follows:

Fiber — is a particle with an aspect ratio of three to one or greater with substantially parallel sides.
Bundle — is a particle composed of fibers in a parallel arrangement, with each fiber closer than the diameter of one fiber.
Clump (or cluster) — is a particle with fibers in a random arrangement such that all fibers are intermixed and no single fiber is isolated from the group.
Matrix — is a fiber or fibers with one end free and the other end embedded or hidden by other particles.

REPORTING OF RESULTS

Asbestos structure concentrations are currently reported in terms of asbestos structures per square centimeter. Originally values were reported in terms of square feet because samples were collected from one foot square areas. To convert structures/sq. sf. to structures/sq. cm divide by 929. Concentrations are based on the number of asbestos structures counted, the area analyzed and the amount of sample prepared. The detection limit for the dust analysis method depends on the size of the area originally sampled and the amount of interfering non-asbestos material. If the dust collected from a 100 square centimeter area is light, typically one-half is prepared for analysis. The detection limit for such a sample is in the range of 160 structures per square centimeter. In dust samples containing high levels of asbestos only a small portion of the original sample may be prepared so that the electron microscope specimens are not overloaded.

INTERPRETATION

There currently are no federal regulations which give acceptable or hazardous levels of fibers in settled dust. Our studies have shown that there exist a number of situations such as on freshly cleaned surfaces and in buildings where no asbestos-containing material is present and no asbestos fibers were detected in dust samples. A level of 150,000 structures per sq. ft. (equivalent to the detection limit of 161 str./sq. cm) was used as a baseline for cleaning furnishings in a high-rise multistory office building contaminated with asbestos partly as the result of a fire in an abatement area (12). Concentrations over a hundred million asbestos structures per sq. cm have been found in some buildings. Concentrations over 1,000 per sq. cm are considered elevated and over 100,000 are in the range found when an abatement project barrier had been breached. Currently, there are several ongoing studies to determine how airborne fiber concentrations are affected by normal building activities which disturb settled dust containing various amounts of fibers.

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